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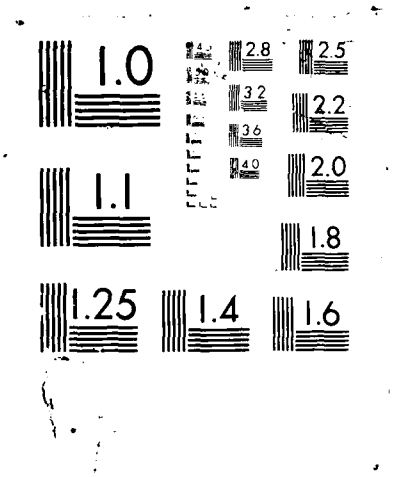
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The work done on this grant focused on the ultraviolet stability problem in the four-dimensional Yang-Mills field theories.

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The work done on this project is on the ultraviolet stability problem in the four-dimensional pure Yang-Mills field theories. These theories, as all quantum field theories, are defined formally by infinite-dimensional functional integrals. To give them a mathematical meaning it is necessary to regularize them. K. Wilson has proposed a regularization replacing these integrals by well-defined finite-dimensional ones. This is a lattice regularization, replacing a gauge field theory on a continuous space by a theory on a discrete lattice with a small lattice spacing e. The ultraviolet stability problem is to prove uniform bounds for the regularized integrals. This problem was studied using the so-called "block-spin" group renormalization method, introduced also by K. Wilson. The main idea of the method is to divide the integration into a sequence of subintegrations in such a way that it is much easier to analyze each subintegral. Acareful and lengthy analysis reduces the problem to a problem of constucting and investigating some finite dimensional dynamical systems, and especially its fixed points and behavior in a neighborhood of the fixed points.

The mathematical investigation of this program was initiated by the author, and the strongest results obtained previously concerned approximate four-dimensional gauge field theories, in which the functional integrals were restricted to a "small field" region by a sequence of complicated restrictions imposed on the field variables.

In this project the complete models are treated. The main obstacle in the problem, and in similar problems for other models, was a lack of understanding of properties connected with the "large field" regions. The basic technical progress of the work in this project is the creation of a systematic method to deal with these "large field" problems.

Unfortunately, it is quite involved and technical (in a mathematical sense), and cannot be described here. This method allowed the author to discuss the complete models, and to complete the proof of the ultraviolet stability for the physically important four-dimensional gauge field theories. The results of the work are published as the preprint: "Renormalization group approach to lattice gauge field theories. II. Analysis of effective densities and their expansions, in the complete models."

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